Metal Oxide Semiconductor Field Effect Transistor

MOSFET

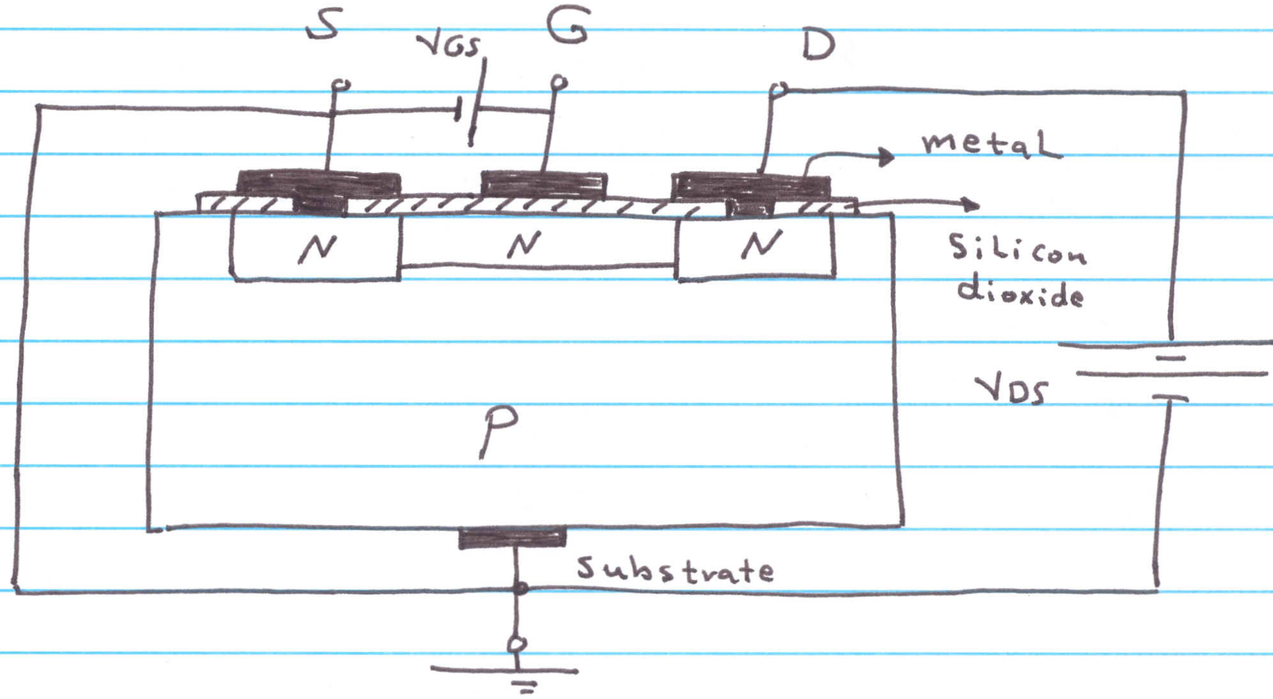
1) Depletion type MOSFET : DMOSFET
2) Enhancement type MOSFET : EMOSFET

The MOSFET differs from the JFET in that it has no pn junction structure ; instead, the gate of the MOSFET is insulated from the channel by a silicon dioxide (SiO_2) layer.

Due to this the input resistance of MOSFET is greater than JFET.

Depletion type MOSFET

Construction of n-channel DMOSFET :



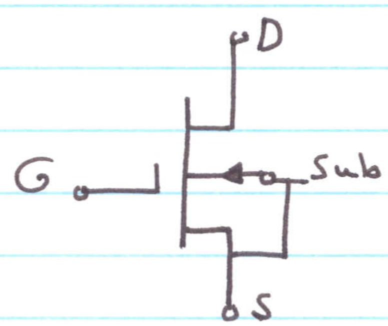
Operation, characteristic and Parameters of DMOSFET :

* **n-channel DMOSFET**

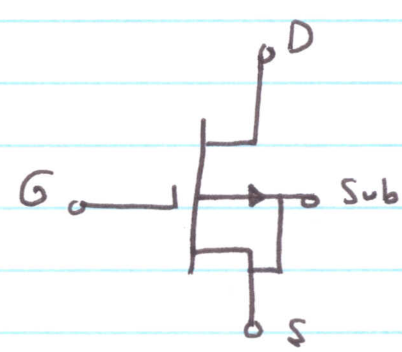
- On the application of V_{DS} and keeping $V_{GS} = 0$ electrons from the n-channel are attracted towards positive potential of the drain terminal
- This establishes current through the channel to be denoted as I_{DSS} at $V_{GS} = 0$
- If we apply negative gate voltage ($V_{GS} < 0$) the negative charges on the gate repel electrons

from the channel. The number of repelled electrons depends on the magnitude of the negative voltage V_{GS}.

- The greater the negative voltage applied at the gate, the level of drain current will reduces until it reaches zero; $V_{GS} = V_p$
- For positive values of V_{GS}, the positive gate will draw additional electrons from the p-type substrate and the drain current increases.

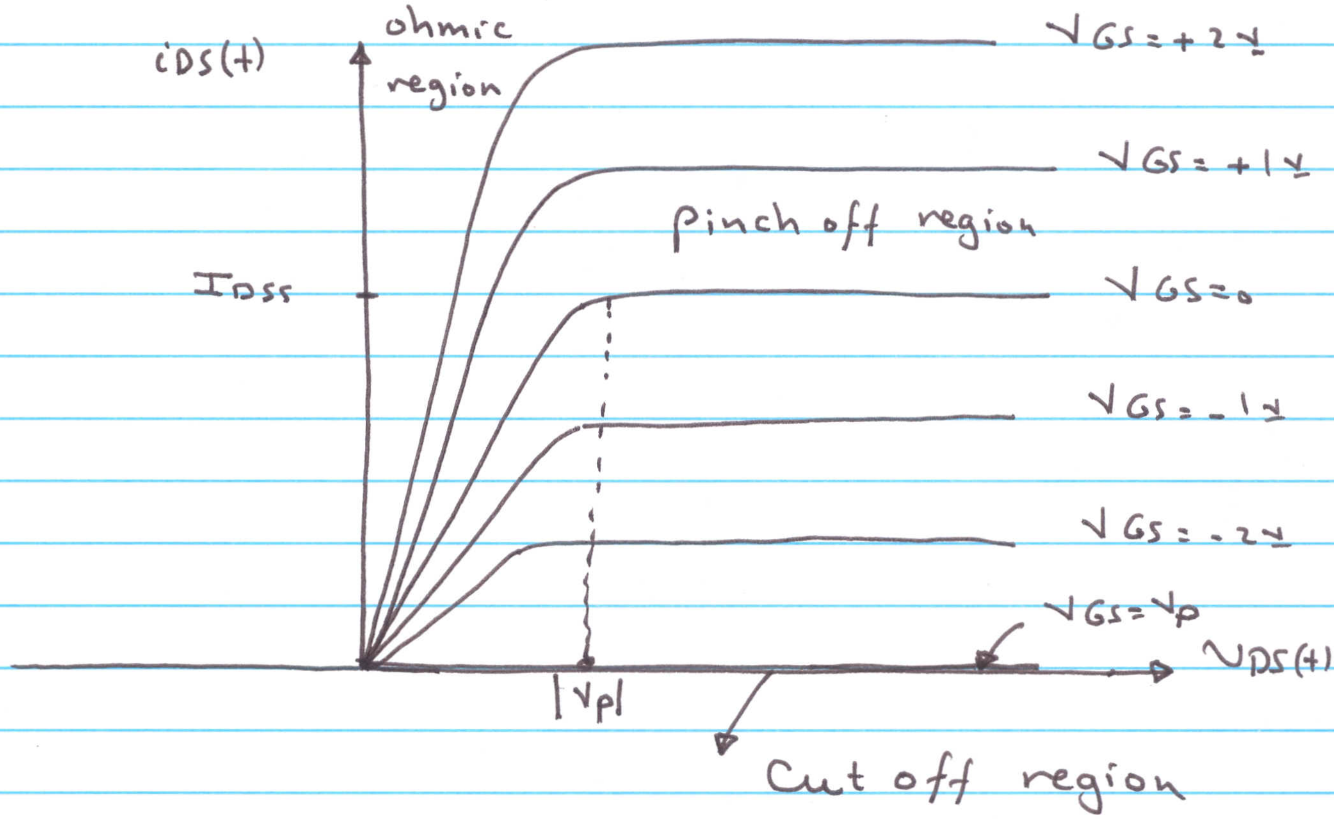


n-channel DMOSFET

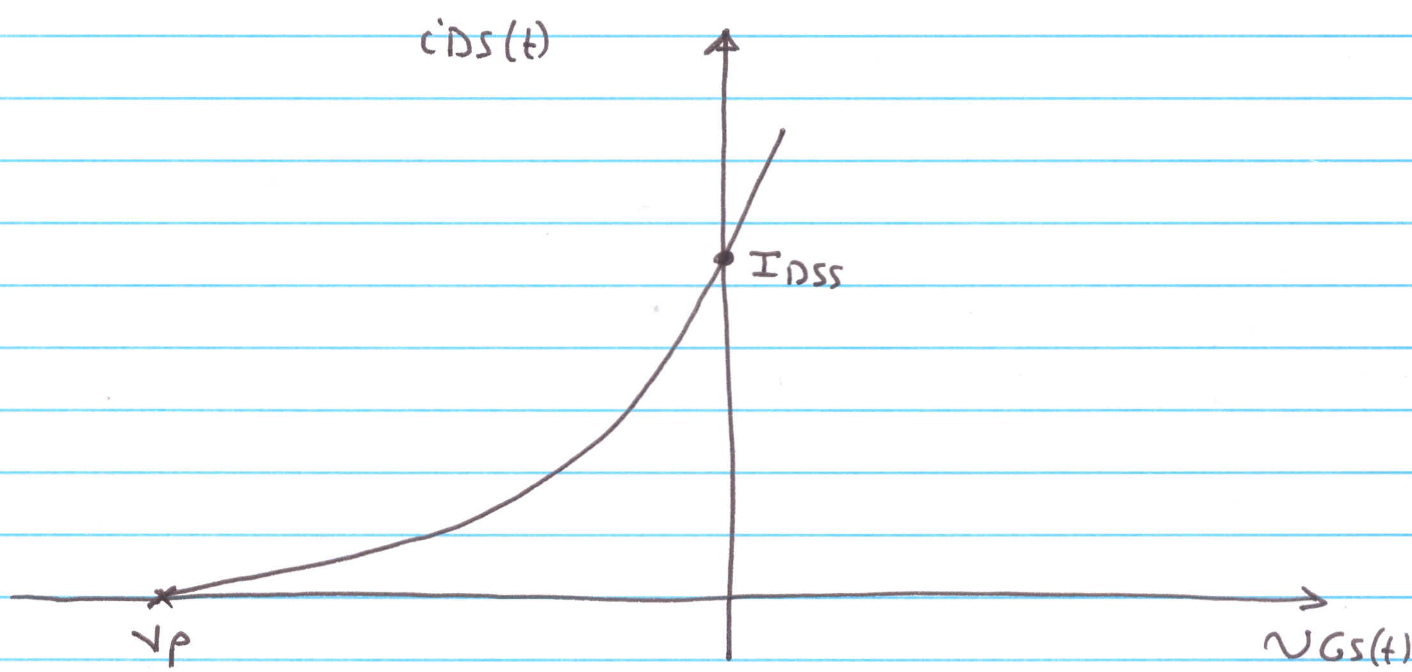


p-channel DMOSFET

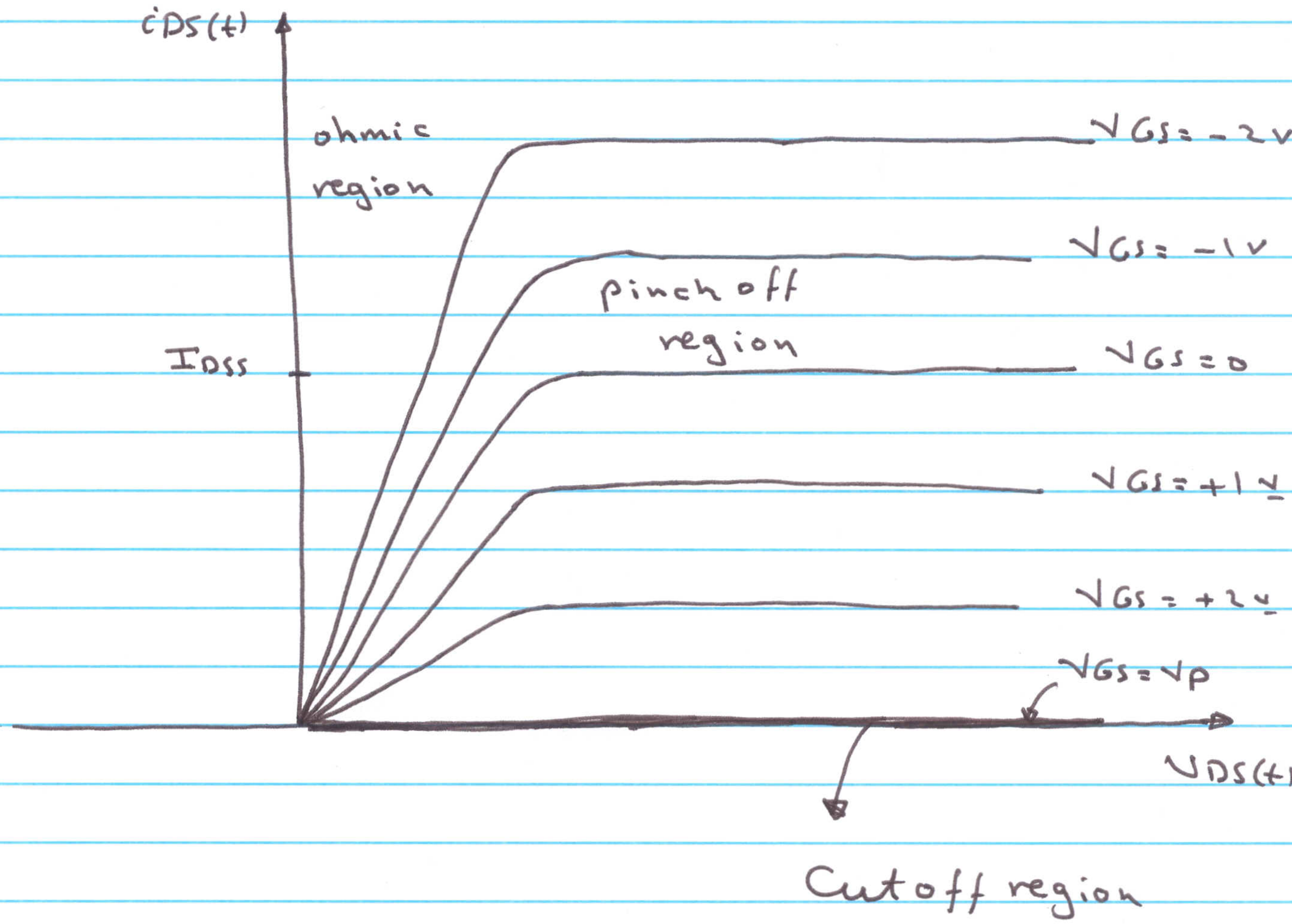
Drain characteristics for an n-channel DMOSFET



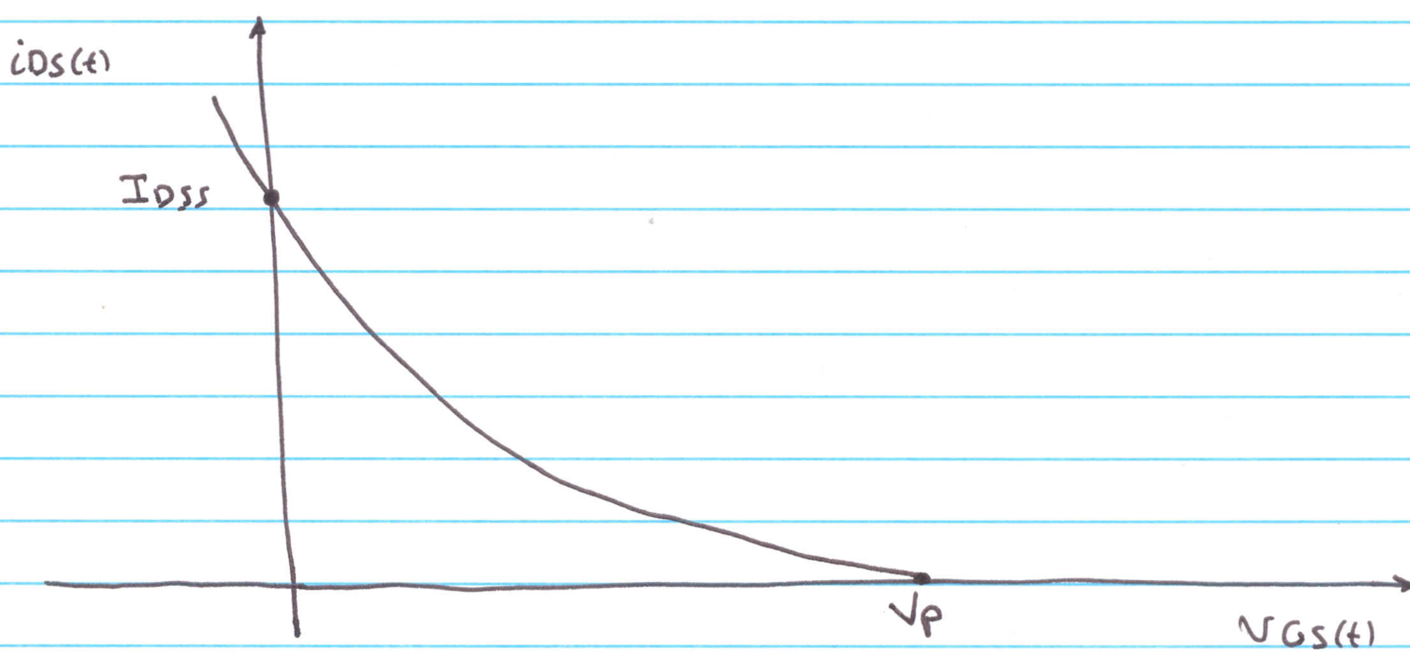
Transfer characteristic for an n-channel DMOSFET



Drain characteristics of p-channel DMOSFET



Transfer characteristic of p-channel DMOSFET :



In the pinch off region

$$i_{DS}(t) = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

For the n-channel

$$V_{GS} > V_P \text{ (negative)}$$

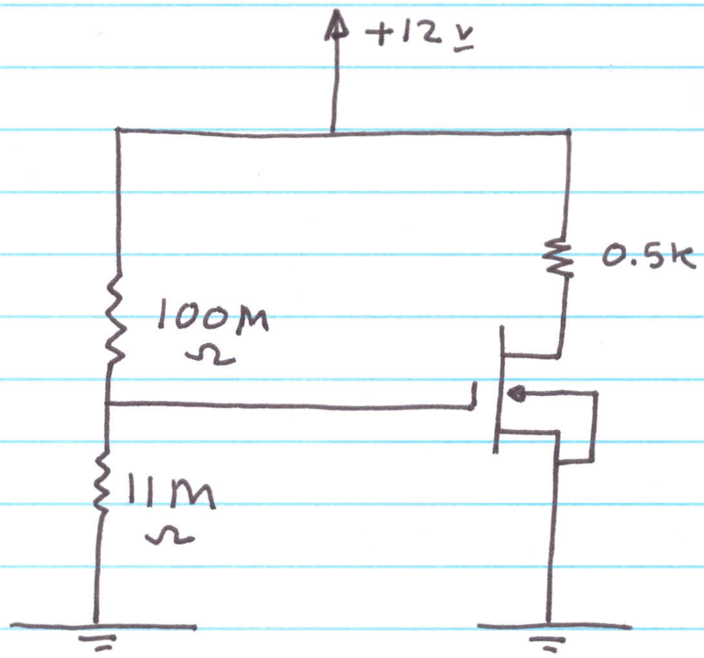
and $$V_{DS} > V_{GS} - V_P$$

For the p-channel

$$V_{GS} < V_P \text{ (positive)}$$

and $$V_{DS} < V_{GS} - V_P$$

Example



$V_P = -5V$

$I_{DSS} = 4mA$

Suppose that the DMOSFET is in the pinch off region

$$I_{DS} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2 \quad \text{——} (1)$$

$$V_{GS} = V_G - V_S = V_G$$

$$V_G = \frac{11M}{11M + 100M} \cdot (12) = 1.19\,V \quad \text{——} (2)$$

sub (2) into (1), we get

$$I_{DS} = 6.13\,mA > I_{DSS} \;!!$$

$$V_{DS} = V_{DD} - 0.5k\, I_{DS} = 8.93\,V$$

$$V_{DS} \overset{?}{>} V_{GS} - V_P = 6.19\,V \quad \checkmark$$